PTO 07-5622

CC=JP DATE=19910611 KIND=A
PN=03137239

TIRE CORD FABRIC
[Taiyakoodo sudare orimono]

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UNITED STATES PATENT AND TRADEMARK OFFICE
Washington, D.C. July 2007

Translated by: FLS, Inc.

PUBLICATION COUNTRY	(19):	JP
DOCUMENT NUMBER	(11):	030137239
DOCUMENT KIND	(12):	A [PUBLISHED UNEXAMINED APPLICATION]
PUBLICATION DATE	(43):	19910611
APPLICATION NUMBER	(21):	020228110
APPLICATION DATE	(22):	19860929
INTERNATIONAL CLASSIFICATION	(51):	D 02 G 3/48; D 03 D 1/00
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TITLE	(54):	TIRE CORD FABRIC
FOREIGN TITLE	(54A):	TAIYA KOODO SUDARE ORIMONO

Specification /279*

1. Title of the Invention

Tire Cord Fabric

2. Claims

(1) A tire cord fabric characterized by fluid jet textured yarns that consist of core yarns and sheath yarns composed of polyester, that have loops and saggings, and that satisfy the following conditions, (a) - (e), being used as wefts at the density of 2 yarns per 5cm and characterized by polyester tire cords being used as warps at the density of 40 yarns per 5 cm,

(a) the binding coefficient K between the core yarn and sheath yarn is between 0.65 and 1.3 [provided that K = (rupture elongation of the original yarn of core yarn) / (rupture elongation)],

(b) the elongation at the primary yielding point is no more than 6%,

(c) the pull resistance A of the core yarn at the primary yielding point is no less than 0.57g/de [provided that A = (load at the primary yielding point - 18.2g) / (fineness de of the core yarn)],

(d) the rupture elongation is no less than 100%, and

(e) the dry-heat shrinkage percentage is no more than 3%.

(2) A tire cord fabric according to Claim (1), wherein the fineness ratio between the core yarn and sheath yarn in the weft is between 1:1 and 6:1.

(3) A tire cord fabric according to Claim 1, wherein the warp consists

* Numbers in the margin indicate pagination in the foreign text.

of two 1000de yarns, two 1500de yarns, or three 1000de yarns plied together.

3. Detailed Description of the Invention

<Technical Field of the Invention>

The invention relates to a tire cord fabric.

<Related Art>

In general, a tire-reinforcing cord fabric employing stretchable yarns as its wefts elongates as the spaces between the cords increase during the cylindrical molding of the tire molding process and therefore has the effects of making the tire molding uniform while maintaining the cord intervals between the warps constant.

As such a stretchable yarn, it has been suggested to use a core yarn obtained by using an undrawn yarn composed of polyester or the like as the core yarn and by then coating it by means of spinning. When this core yarn is used as the wefts of a tire cord fabric, the warp cords are /280
effectively retained at appropriate locations, and the weaves of the fabric can be stabilized during the handling and weaving process.

However, the manufacture of such stretchable core yarns requires a special core yarn spinning device, and the manufacturing cost is also high.

Also, it has been suggested to provide the surface of an undrawn polyamide yarn with many filament loops by subjecting the yarn to air jet bulking and to then use the resultant stretchable bulked yarn as the wefts of a tire cord fabric (JP S58-104238A, JP S60-110943A). Although 6-nylon and 6,6-nylon are utilized in the above cases, 6-nylon has poor heat resistance and cannot be used as the wefts of a polyester tire cord

that needs to be heat-treated at a high temperature. Also, 6,6-nylon is expensive to manufacture in comparison to polyester and cannot be utilized industrially.

<Purpose of the Invention>

The purpose of the invention is to provide a cord fabric that employs a fluid jet textured yarn that has high elongation properties, that contains many stably existing loops and saggings, that is easy to handle during the weaving process, and that is composed of polyester.

<Structure of the Invention>

The present invention is a tire cord fabric characterized by fluid jet textured yarns that consist of core yarns and sheath yarns composed of polyester, that have loops and saggings, and that satisfy the following conditions, (a) - (e), being used as wefts at the density of 2 yarns per 5cm and characterized by polyester tire cords being used as warps at the density of 40 yarns per 5 cm.

(a) The binding coefficient K between the core yarns and sheath yarns is between 0.65 and 1.3 [provided that K = (rupture elongation of the original yarn of core yarn) / (rupture elongation)].

(b) The elongation at the primary yielding point is no more than 6%.

(c) The pull resistance A of the core yarn at the primary yielding point is no less than 0.57g/de [provided that A = (load at the primary yielding point - 18.2g) / (fineness de of the core yarn)].

(d) The rupture elongation is no less than 100%.

(e) The dry-heat shrinkage percentage is no more than 3%.

The polyester mentioned in the invention is polyester containing ethylene terephthalate as the main structural units, and it may be polyester in which part of the terephthalic acid component has been replaced by another dicarboxylic acid component or polyester in which part of the ethylene glycol component has been replaced by another diol component. Its degree of polymerization is normally between 100 and 110.

In a fluid jet textured yarn (taslan yarn) of the invention, the binding coefficient K between the core yarn and sheath yarn that constitute the yarn must be in the range between 0.65 and 1.3 (K = (rupture elongation of the original yarn of the core yarn) / (rupture elongation of the taslan yarn)). If K is less than 0.65, the degree of binding (i.e. degree of interlacing) is low and the rupture elongation of the taslan yarn becomes high. However, the large loops of the taslan yarn make the yarn difficult to handle in the later process, and the function for retaining the warps of the woven cord fabric in appropriate locations cannot be demonstrated sufficiently. On the other hand, if K is greater than 1.3, the binding increases and reduces the sizes of the loops. As a result, the necessary rupture elongation cannot be obtained. In this manner, the binding coefficient K specifies the relationship between the rupture elongation of the core yarn and the rupture elongation of the taslan yarn which are influenced by the degree of binding between the core yarn and sheath yarn.

Moreover, according to the present invention, it is necessary that the elongation of the taslan yarn at the primary yielding point be no more than 6%. If this elongation is greater than 6%, the weaving and handling properties of the cord fabric will be poor.

Moreover, it is necessary that the pull resistance A of the core yarn of the taslan yarn at the primary yielding point be no less than 0.57g/de, provided that the following is true: A = (load at the primary yielding point - 18.2g) / (fineness de of core yarn). If A is less than 0.57, the weaving and handling properties of the cord fabric will be poor.

A taslan yarn of the invention is provided with the physical properties, (b) - (e), by preparing a yarn having the binding coefficient K indicated in (a) through a fluid jet process and by then heat treating it. At the time of the heat treatment, the sheath yarn that is entangled around the core yarn shrinks. This shrinking action increases the load (stress) of the taslan yarn itself at the primary yielding point by means of the mutual frictional forces of the filaments making up the core yarn. Since this value primarily depends on the fineness de of the core yarn, it is obtained as the pull resistance A of the core yarn when /281
it is corrected by using the fineness de of the core yarn.

Furthermore, the taslan yarn must have a rupture elongation of no less than 100% and a dry-heat shrinking percentage of no more than 3% when subjected to a heat treatment at 150°C for 30 minutes in a free state. If these ranges of rupture elongation and dry-heat shrinking percentage are deviated from, the workability of the cord fabric during the tire formation and the uniformity of the obtained tire will be poor.

The fineness ratio between the core yarn and sheath yarn of a weft yarn of the invention can be within a wide range, although the range between 1:1 and 6:1 is preferred. The total fineness of this weft should preferably be in the range between 130 and 270de.

The polyester yarn used for the manufacture of the above taslan yarn needs to have a rupture elongation of no less than 120%, and is obtained by, for example, a method in which high-speed spinning is carried out at the spin rate of between 2500 and 6000m/min. or a regular method in which an undrawn yarn having been spun at the spin rate of, for example, between 800 and 1500m/min. is drawn at low magnification.

The yarn obtained by the above method has a high dry-heat shrinking ratio (under the measurement conditions of 150°C and 30 minutes) and poor dimensional stability. In order to improve this and further increase the rupture elongation, the core yarn is heat-treated by being placed in boiling water under normal pressure or by being passed through hot air of 120°C or higher while being overfed in order to lower the dry-heat shrinkage percentage to no more than 10% and to also increase the rupture elongation by at least 10%. At this time, the overfeeding ratio should be between 8 and 40%. It should not exceed 40% since the Young's modulus becomes lower and the handling properties will be poor in the later process. If the overfeed percentage is less than 8% or the heat-dry temperature is less than 120°C, the predetermined dry-heat shrinking rate cannot be achieved, and the rupture elongation will not increase by 10% or more.

By using a yarn having been subjected to the above process as the core yarn and a polyester yarn that has not been subjected to a heat treatment and that has a rupture elongation of at least 120% as the sheath yarn, regular air jet bulk texturing (2-feed fluid jet texturing) is carried out. If the degree of binding becomes too high at this time, a high-elongation bulk textured yarn having a rupture elongation of no less

than 100% cannot be obtained. Therefore, the conditions should be set so that the overfeed percentage of the core yarn will be no more than 5% and so that the binding coefficient between the core yarn and sheath yarn will be between 0.65 and 1.3. Moreover, the overfeed percentage of the sheath yarn needs to be at least 50% in order to stabilize the weaves of the fabric. Moreover, the difference between the overfeed percentages between the sheath yarn and core yarn should be at least 48% in order to achieve a rupture elongation of at least 100% and to also stabilize the weaves of the fabric.

Since the yarn having been subjected to the above process has large loops and will be unfavorable in terms of handling in the later process, it is subjected to a dry-heat treatment. At this time, mainly the sheath yarn that has a high dry-heat shrinking rate shrinks and causes the loops to become smaller. As a result, the handling properties of the yarn improve drastically for the later process. At this time, the appropriate overfeed percentage is between -10 and 30%, and the appropriate dry-heat treatment temperature is between 100 and 230°C. If the overfeed percentage is -20% or less, the rupture elongation will decrease, and if the treatment temperature is less than 100°C, the effect of reducing the sizes of the loops is small. If the overfeed percentage is greater than 30% or if the treatment temperature is higher than 230°C, the degree of interlacing between the filaments will be too high, making it difficult for the rupture elongation of the high-elongation bulk textured yarn to be 100% or higher.

These conditions should be suitably adjusted by using the strength, primary yielding point, number of filaments, single yarn de, and core

effect of the original yarn used. Moreover, if the heat-dry shrinking percentage of the wound yarn is still high and the pull resistance A is low, it is permissible to subject the wound yarn to a heat treatment as it is or after unwinding it. In this process, the loops and saggings of the high-elongation bulk textured yarn are confined by the rolled layer. Therefore, the degrees of shrinkage of the loops and saggings of the yarn are relatively small, and the yarn generally has a low dry-heat shrinkage rate and a high pull resistance A. The heat-treatment temperature should appropriately be between 80 and 140°C for wet heating and between 110 and 230°C for dry heating. If the temperature is less than 80°C for wet heating or less than 110°C for dry heating, the achieved effect will be small. A temperature that is higher than 140°C for wet heating or higher than 230°C for dry heating is not appropriate since it decreases the rupture elongation.

If the rupture elongation of the weft of the invention is less than 100%, the elongation of the weft will be insufficient during tire molding, and the target uniform tire cannot be obtained. Moreover, if the dry-heat shrinkage rate of the weft is too high, the dimensional stability of the fabric against heat will deteriorate and it becomes difficult to acquire the target tire as designed. Therefore, the dry-heat shrinkage rate should be no more than 3%.

By using the fluid jet textured yarns obtained from the above process as wefts at the density of 2 yarns per 5cm or more and by using /282 polyester tire cords as the warps at the density of 40 yarns per 5cm or more, a tire cord fabric is prepared.

As the polyester tire cords used as the warps, twist yarns consisting of 1000de × 2 yarns, 1500de × 2 yarns, or 1000de × 3 yarns are utilized. These cords can be obtained by a commonly known method, and the range of the twist count should preferably be between 21,000 and 23,000 in terms of the twist constant. For 1000de × 2 yarns, the twist count should be 490T/m, and for 1500de × 2 yarns, the twist count should be 400T/m.

Moreover, if the density of said wefts is less than 2 yarns per 5cm, the intervals of the warps cannot be maintained, and the effect of the wefts therefore cannot be achieved. Moreover, if the density of the warps is less than 40 yarns per 5cm, the binding forces between the wefts and warps decrease due to the significantly low density of the wefts. This causes the warps to shift, making it impossible to maintain the intervals of the warps. As for the upper limit of the density of the warps, it is possible to increase the number of yarns (which varies depending on the thicknesses of the wefts) as long as the warps can be arranged physically, but increasing the number of the wefts unduly is meaningless from the perspective of preserving the intervals between the warps and is also economically disadvantageous (It is normally 7 yarns per 5cm or less).

<Embodiments of the Invention>

In the following, the present invention will be described in detail based on embodiments. In the following embodiments, the device illustrated in Figure 1 was utilized for the manufacture of the wefts.

Figure 1 shows one example of a device suitable for the manufacture of wefts of the invention. In the figure, reference numeral 1 denotes a package for a core yarn, 2 denotes a package for a sheath yarn, 3 denotes

a core yarn feed roller, 4 denotes a heater, 5 denotes a heat-treated core yarn feed roller, 6 denotes a sheath yarn feed roller, 7 denotes an air jet nozzle, 8 denotes a pull roller (also used as a feed roller to the heater), 9 denotes a heater, 10 denotes a pull roller, and 11 denotes a winder.

Embodiment 1

An undrawn 24-filament polyethylene terephthalate yarn which had been obtained by means of melt spinning at the winding rate of 4000m per minute and which had the rupture elongation of 122%, shear strength of 332gr, and fineness of 165de was passed through a heater, which was 1.00m in length and 163°C in temperature, at the yarn feed rate of 149m per minute and overfeed percentage of 20%. After the heat treatment, the rupture elongation was 164% and had increased by 24%.

By using this heat-treated yarn as a core yarn and by using an undrawn 12-filament polyethylene terephthalate yarn which was obtained by means of melt spinning at the winding rate of 3800m per minute and which had the rupture elongation of 118%, shear strength of 88gr, and fineness of 45de as a sheath yarn, air jet bulk texturing (fluid jet texturing) was carried out. The conditions of the above texturing were as follows: core yarn overfeed percentage = 1%; sheath yarn overfeed percentage = 100%; fluid/air pressure = 4.0kg/cm^2 G; core yarn feed rate = 124.2m per minute; sheath yarn feed rate = 246m per minute; and textured yarn feed rate = 123m per minute. In addition, in order to weaken the binding between the core yarn and sheath yarn, water was not applied to the core-in-sheath yarn prior to the yarn arriving at the air jet nozzle. (As the method

for weakening the binding, it is permissible to reduce the fluid/air pressure or to increase the yarn texturing rate.)

The above air jet bulk textured yarn was heat-treated by being passed through the 160°C heater at the yarn rate of 123m per minute and overfeed percentage of 0% and was then taken up at the yarn rate of 123m per minute. The rupture elongation of the obtained fluid jet textured yarn was 151%, and the pull resistance A [A = (load at the primary yielding point - 18.2gr) / fineness of the elongation [Translator's note: This appears to be a typo for "core yarn."]] was 0.65g/de. The above yarn was further subjected to wet-heat setting for 30 minutes at 105°C.

The obtained yarn had the fineness of 300de, core - sheath fineness ratio of 2.22 : 1, rupture elongation of 149%, pull resistance A of 0.87g/de, dry-heat shrinking percentage of 2%, binding coefficient K of 0.82, and elongation of 3.8% at the primary yielding point. By using this yarn as wefts at the weft density of 3 yarns per 5cm and by using 1000de × 2 yarns (first twist = Z 490T/m; second twist = S 490T/m) of polyethylene terephthalate tire cords as warps, a fabric for a radial tire carcass having the density of 49.4 yarns per 5cm was woven.

A resorcin formaldehyde solution having a composition that rubber-bonded to polyester was applied to the above fabric, which was then dried for 4 minutes at 150°C and was then heat-treated for 2 minutes at 240°C. The strength and rupture elongation of the wefts after the heat treatment were 421g and 117%, respectively.

By using this tire cord fabric, a 165-SR-B-size radial tire was molded. During the molding of the green tire, the wefts became spread /283

out following the widening of the intervals between the warps and the warps were aligned uniformly in the expanding process of the formed carcass. In this case, the tire's uniformity level (radial force variation level) was 8.5kg without any irregularities detected on the side walls, and the results were extremely favorable.

Embodiment 2

Fluid jet texturing was carried out under the same conditions as those of Embodiment 1 except for utilizing an undrawn 36-filament polyethylene phthalate yarn which had been obtained by means of melt spinning at the winding rate of 3900m per minute and which had the rupture elongation of 122.0%, shear strength of 252gr, and fineness of 125de as the core yarn instead of the yarn used in Embodiment 1.

The obtained yarn had the fineness of 260de, core - sheath fineness ratio of 1.68 : 1, rupture elongation of 156%, pull resistance A of 0.72g/de, dry-heat shrinking percentage of 2.1%, binding coefficient K of 0.78, and elongation of 5.0% at the primary yielding point. Under the same conditions as those of Embodiment 1 except for utilizing the above yarn, a radial tire fabric was produced. The rupture elongation of the fabric after it had been subjected to a heat treatment at 240°C was 115%.

Comparative Example 1

The texturing of Embodiment 1 was carried out under the same conditions except for applying water to the core yarn prior to the taslan texturing. The obtained yarn had the fineness of 303de and rupture elongation of 97%. By carrying out the same process as that of Embodiment 1 except for using this textured yarn as the wefts, a fabric for a radial

tire carcass was woven. Because of the insufficient rupture elongation of the wefts, a uniform tire could not be obtained.

4. Brief Description of the Drawing

Figure 1 illustrates one example of a device suitable for manufacturing the weft yarns of the invention.

In the figure, reference numeral 1 denotes a package for a core yarn, 2 denotes a package for a sheath yarn, 3 denotes a core yarn feed roller, 4 denotes a heater, 5 denotes a heat-treated core yarn feed roller, 6 denotes a sheath yarn feed roller, 7 denotes an air jet, 8 denotes a pull roller (also used as a feed roller to the heater), 9 denotes a heater, 10 denotes a pull roller, and 11 denotes a winder.

Figure 1